

Elliptically Polarizing Undulators for MAX IV

A.Thiel (MAX IV), H.Tarawneh (MAX IV), A.Gaupp (HZB BESSY II), CAD by Projekt Konstruktioner AB



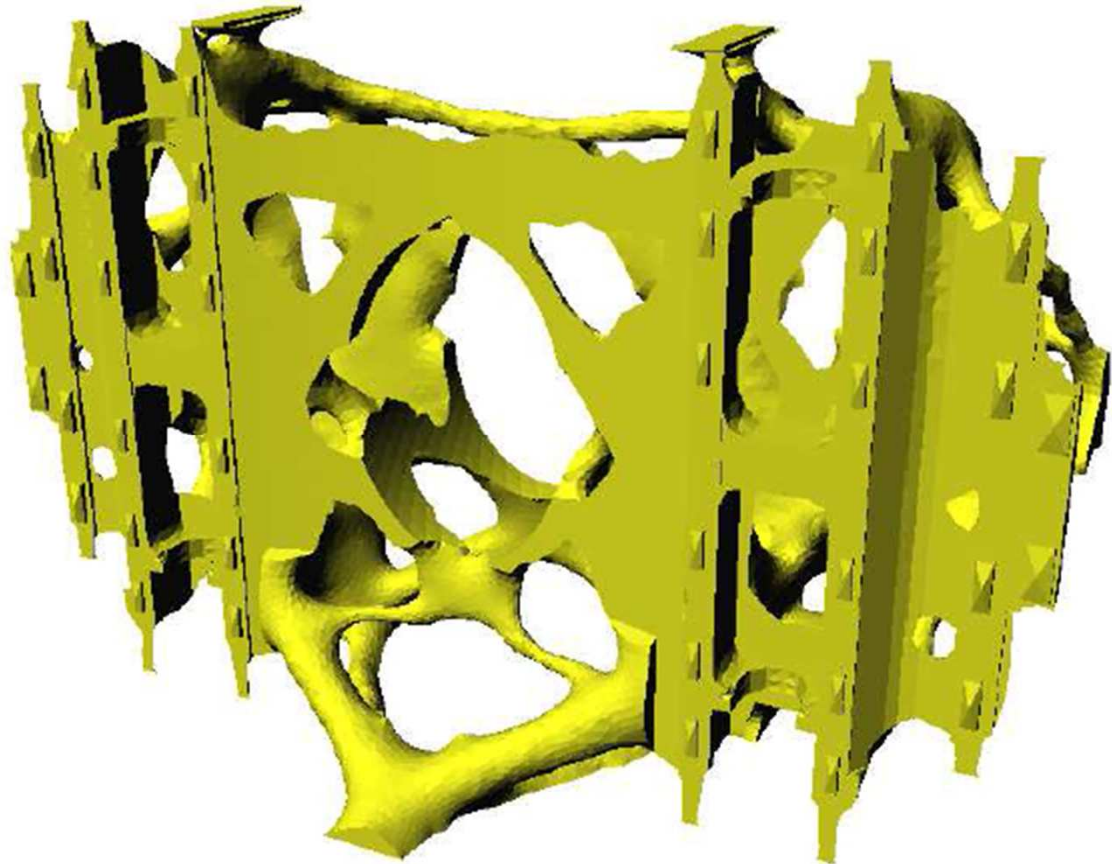
At present five elliptically polarizing undulators (EPU), designed by MAX IV, will be built to serve several beamlines at the two MAX IV storage rings. The period length of the EPU's ranges from 48 to 95mm.

The magnetic gap ranges from 11mm to 200mm with a thickness of 10mm of the straight section vacuum chamber. The devices come in two lengths: about 2.6m for the 1.5GeV-ring and about 4.0m for the 3GeV ring with a calculated weight up to 13t. The height of the electron beam is 1300mm.

The main frame structure of the undulators will be made of nodular cast iron. The biggest challenge, in terms of mechanical design, is currently to keep the mechanical deformation of the main girders within acceptable range without compromising beam quality. All EPU's will stand on three feet in order to ease alignment.

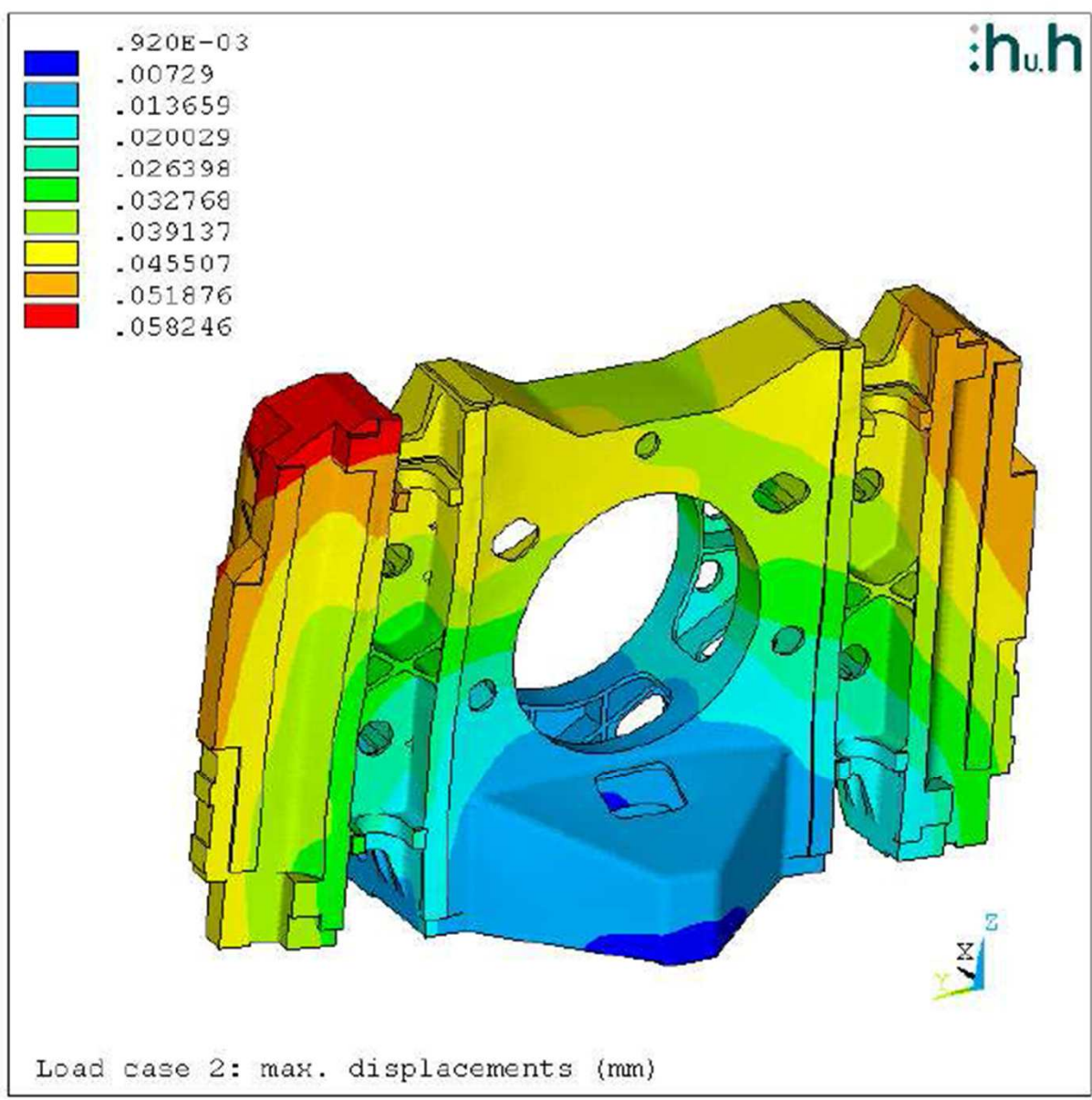
	EPU 48	EPU 53	EPU 61	EPU 84	EPU 95
Location	3 GeV ring	3 GeV ring	1.5 GeV ring	1.5 GeV ring	1.5 GeV ring
Period	48 mm	53mm	61mm	84mm	95mm
Total length	3905 mm	3905 mm	2800mm	<2800mm	<2800mm
Minimum gap	11 mm	11mm	14mm	14mm	14mm
Maximum gap	200 mm	200 mm	200 mm	200 mm	200 mm
Magnets	30x30x12	30x30x13.25	30x30x15.25	30x30x21	30x30x23.75
Min. Photon energy range	160 eV...385 eV	115 eV...270 eV		7 eV...17 eV	4 eV...11 eV

The main frame structure of the undulators will be made of nodular cast iron EN-GJS-400-18-RT. Based on the calculated forces at the suspension points of the girders a frame topology was developed, which resulted in the final cast frame design. The weight of the frame is 6105 kg.

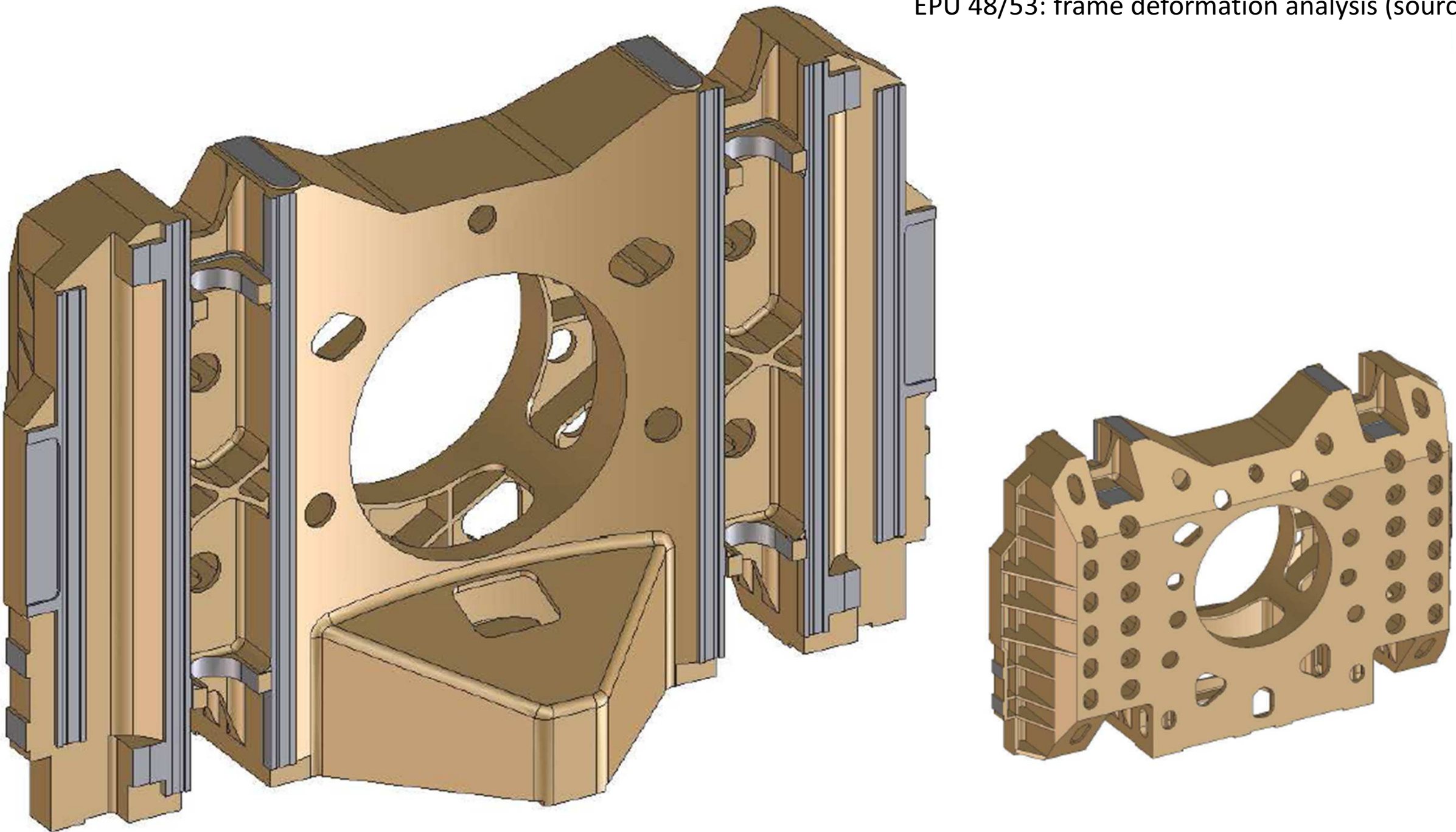


Cast frame topology (source: Heidenreich & Harbeck, Germany)

The allowable deformation of the main girder is 0.02mm. The frame is designed to achieve that demand, calculation shows the maximum deformation is below 0.02mm. The main girders have 4 suspension points on the frame and a very stiff cross section. According to calculation the deformation range of the main girders at maximum magnet force is at 0.02mm.

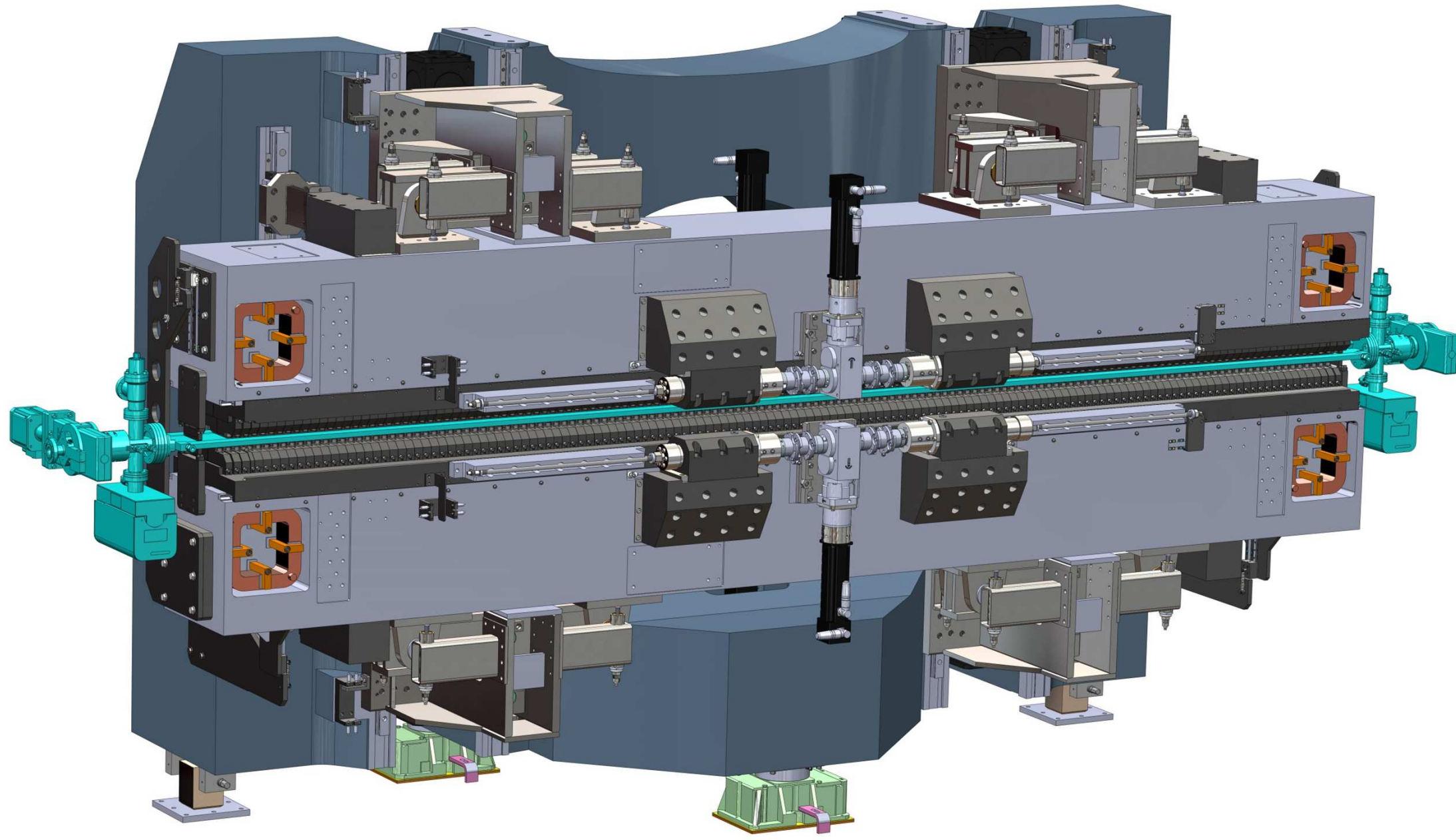
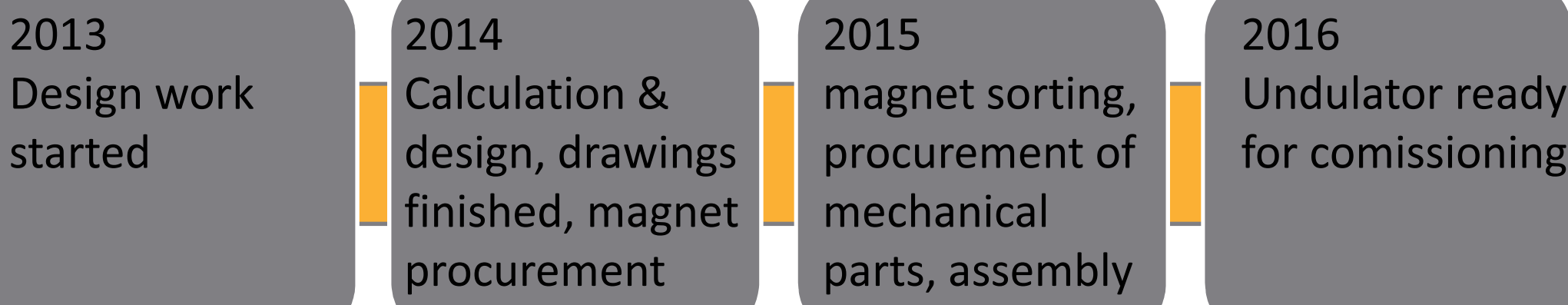


EPU 48/53: frame deformation analysis (source: Heidenreich & Harbeck, Germany)

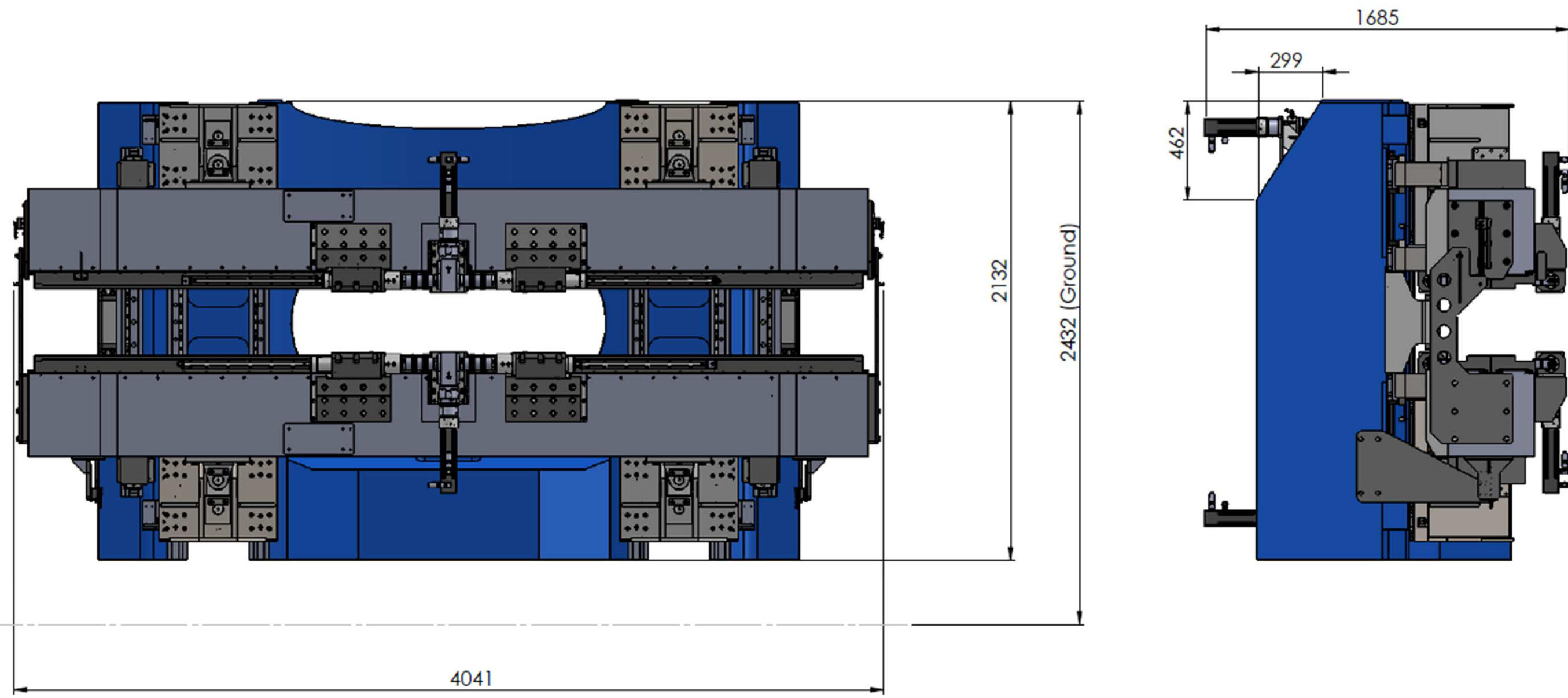


EPU 48/53: final cast frame design (source: Heidenreich & Harbeck, Germany)

EPU 48/53 time line

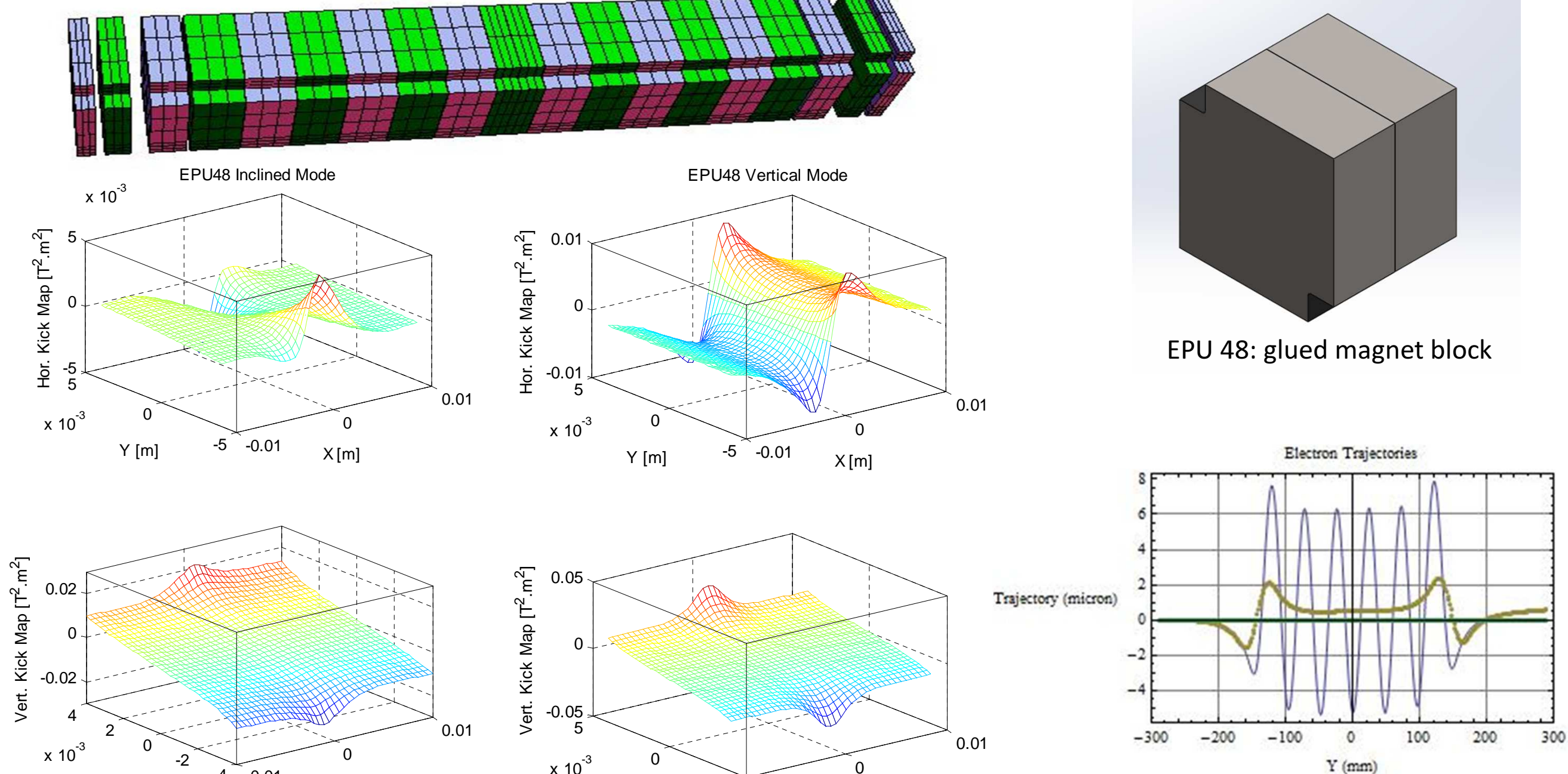


EPU 48 assembly, design status September 2014



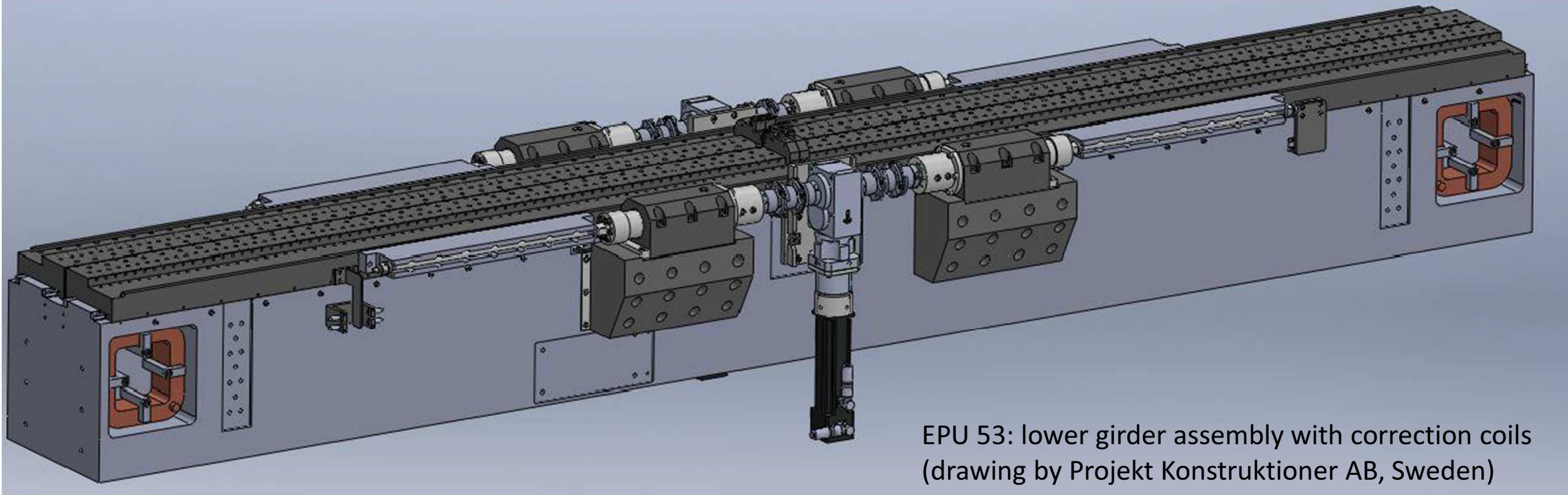
EPU 48/53: main dimensions (drawing by Projekt Konstruktioner AB, Sweden)

The permanent magnets are made of NdFeB. The main magnets are glued to pairs¹. A period consists of two glued blocks. The typical remanence of the permanent magnets is 1.29T at 1464 kA/m coercivity. The end section follows the ESRF design with 3 end magnets.

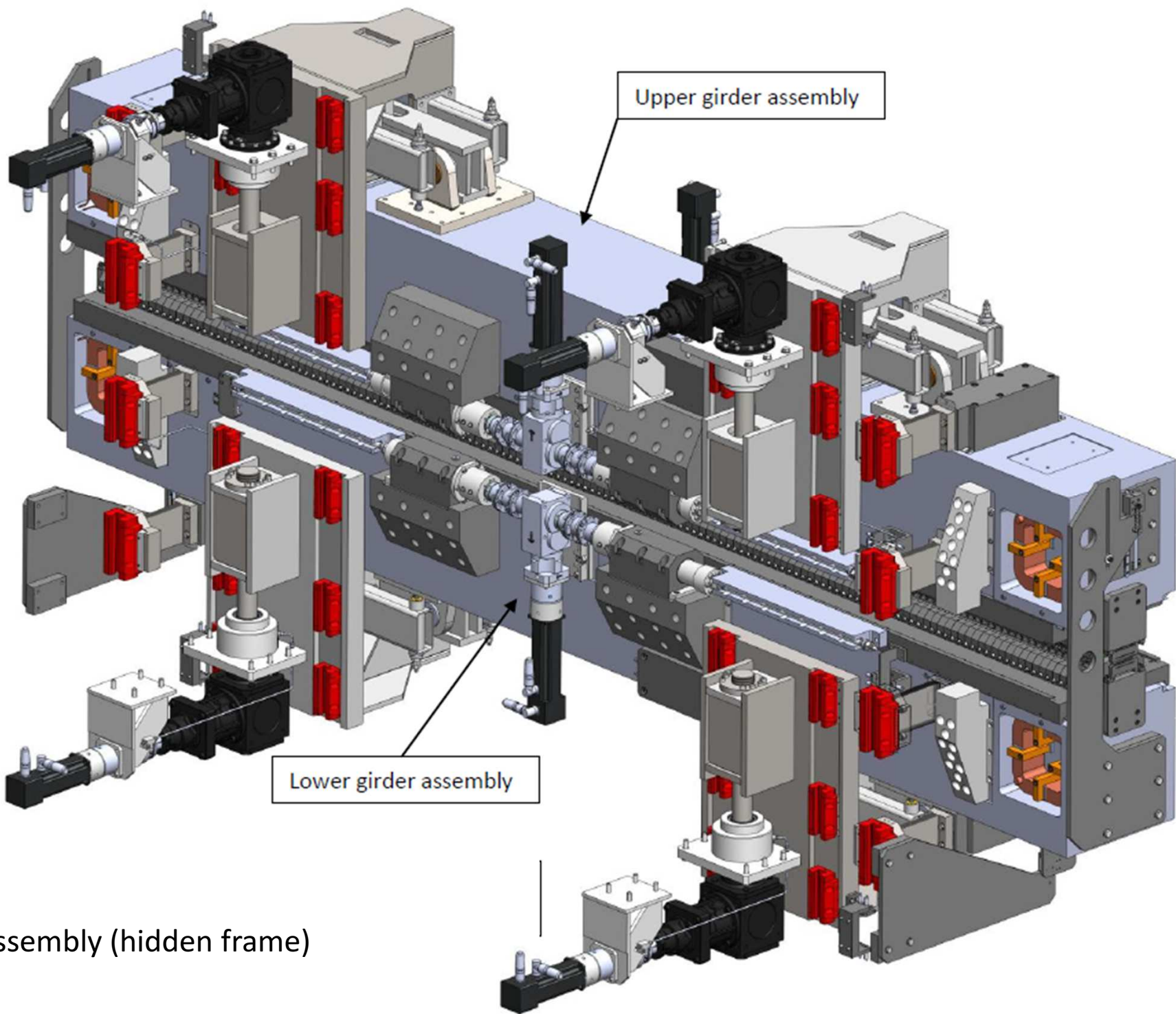


EPU 48: glued magnet block

Correction coils will be assembled as close as possible to the end section on the girder. Water cooled coils are planned to be used. A maximum coil power of 100W is considered sufficient to balance the kick.



EPU 53: lower girder assembly with correction coils (drawing by Projekt Konstruktioner AB, Sweden)



EPU 48: undulator assembly (hidden frame)

¹ Wallén, Blomqvist, Bahrdr, Boergermann: "Novel Magnet Production Technique used for an Elliptically Polarized Undulator", IPAC 2014